PB-239 706

GREEN LAKE, KANDIYOHI COUNTY, MINNESOTA

Pacific Northwest Environmental Research Laboratory

Prepared for:

Minnesota Pollution Control Agency
Minnesota National Guard
National Environmental Research Center

November 1974

DISTRIBUTED BY:

NTIS
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.	3. PB 239 706
4. TITLE AND SUBTITLE Report on Green Lake, Kandiyohi County, Minnesota		5. REPORT DATE Prepared November 1974 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)		8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 101
9. PERFORMING ORGANIZATION NAME AND ADDRESS Pacific Northwest Environmental Research Laboratory U.S.Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330		10. PROGRAM ELEMENT NO. 1BA029 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency		13. TYPE OF REPORT AND PERIOD COVERED Final - 1972 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
US Department of Commerce
Springfield, VA. 22151

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)*	21. NO. OF PAGES
Release unlimited		33
	20. SECURITY CLASS *(This page)*	22. PRICE
		3.75

REPORT

ON

GREEN LAKE

KANDIYOHI COUNTY

MINNESOTA

EPA REGION V

WORKING PAPER No. 101

WITH THE COOPERATION OF THE

MINNESOTA POLLUTION CONTROL AGENCY

AND THE

MINNESOTA NATIONAL GUARD

NOVEMBER, 1974

CONTENTS

	Page
Foreword	ii
List of Minnesota Study Lakes	iv, v
Lake and Drainage Area Map	vi
Sections	
I. Conclusions	1
II. Lake and Drainage Basin Characteristics	3
III. Lake Water Quality Summary	4
IV. Nutrient Loadings	9
V. Literature Reviewed	15
VI. Appendices	16

FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Minnesota Pollution Control Agency for professional involvement and to the Minnesota National Guard for conducting the tributary sampling phase of the Survey.

Grant J. Merritt, Director of the Minnesota Pollution Control Agency, John F. McGuire, Chief, and Joel G. Schilling, Biologist, of the Section of Surface and Groundwater, Division of Water Quality, provided invaluable lake documentation and counsel during the course of the Survey; and the staff of the Section of Municipal Works, Division of Water Quality, were most helpful in identifying point sources and soliciting municipal participation in the Survey.

Major General Chester J. Moeglein, the Adjutant General of Minnesota, and Project Officer Major Adrian Beltrand, who directed the volunteer efforts of the Minnesota National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

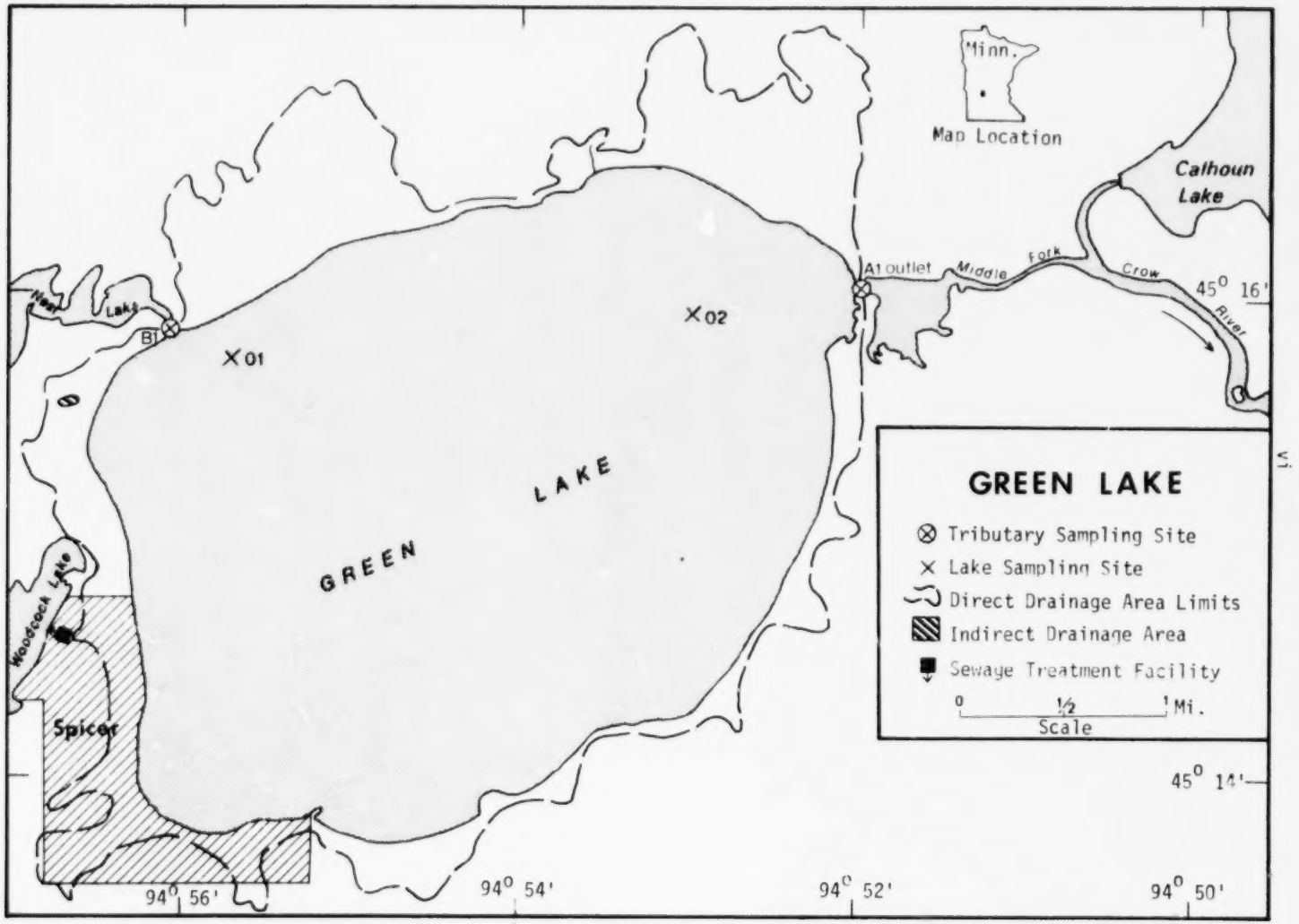
NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF MINNESOTA

LAKE NAME	COUNTY
Albert Lea	Freeborn
Andrusia	Beltrami
Badger	Polk
Bartlett	Koochiching
Bear	Freeborn
Bemidji	Beltrami
Big	Stearns
Big Stone	Big Stone, MN; Roberts, Grant, SD
Birch	Cass
Blackduck	Beltrami
Blackhoof	Crow Wing
Budd	Martin
Buffalo	Wright
Calhoun	Hennepin
Carlos	Douglas
Carrigan	Wright
Cass	Beltrami, Cass
Clearwater	Wright, Stearns
Cokato	Wright
Cranberry	Crow Wing
Darling	Douglas
Elbow	St. Louis
Embarass	St. Louis
Fall	Lake
Forest	Washington
Green	Kandiyohi
Gull	Cass
Heron	Jackson
Leech	Cass
Le Homme Dieu	Douglas
Lily	Blue Earth
Little	Grant
Lost	St. Louis

LAKE NAME	COUNTY
Madison	Blue Earth
Malmedal	Pope
Mashkenode	St. Louis
McQuade	St. Louis
Minnetonka	Hennepin
Minnewaska	Pope
Mud	Itasca
Nest	Kandiyohi
Pelican	St. Louis
Pepin	Goodhue, Wabasha, MN; Pierce, Pepin, WI
Rabbit	Crow Wing
Sakatah	Le Sueur
Shagawa	St. Louis
Silver	McLeod
Six Mile	St. Louis
Spring	Washington, Dakota
St. Croix	Washington, MN; St. Croix, Pierce, WI
St. Louis Bay	St. Louis, MN; Douglas, WI
Superior Bay	St. Louis, MN; Douglas, WI
Swan	Itasca
Trace	Todd
Trout	Itasca
Wagonga	Kandiyohi
Wallmark	Chisago
White Bear	Washington
Winona	Douglas
Wolf	Beltrami, Hubbard
Woodcock	Kandiyohi
Zumbro	Olmstead, Wabasha


Minn.
Map Location
Calhoun Lake
A1 outlet
Middle
Fork
Crow
River
45° 16'
X02
X01
B1
GREEN LAKE
GREEN
Woodcock Lake
Spicer
45° 14'
94° 56'
94° 54'
94° 52'
94° 50'
GREEN LAKE
Tributary Sampling Site
Lake Sampling Site
Direct Drainage Area Limits
Indirect Drainage Area
Sewage Treatment Facility
0 ½ 1 Mi.
Scale

GREEN LAKE

STORET NO. 27B2

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate Green Lake is meso-eutrophic, although water quality is relatively good. Of the 60 Minnesota lakes sampled in the fall when essentially all were well-mixed, only two had less mean total phosphorus, only three had less mean dissolved phosphorus, but 18 had less mean inorganic nitrogen. Of the 80 lakes sampled, 7 had greater Secchi disc transparency, and 6 had less mean chlorophyll a. However, depression of dissolved oxygen with depth occurred in July and late August, particularly at station 1, and blue-green algae were present in all phytoplankton samples.

Survey limnologists observed a light algal bloom in progress in July, 1972.

B. Rate-Limiting Nutrient:

The algal assay results show that Green Lake was phosphorus limited at the time the assay sample was collected. The lake data indicate phosphorus limitation in late August (N/P ratio = 28/1) but nitrogen limitation in July (N/P ratio = <1/1).

C. Nutrient Controllability:

1. Point sources--There are no known nutrient point-sources impacting Green Lake directly. The waste treatment facilities of the villages of Belgrade and New London are discussed in "Report on Nest Lake", Working Paper No. 117, and the Spicer STP discharges to Woodcock Lake which has a high-water overflow to Green Lake.

During the sampling year, Green Lake received a total phosphorus load at a rate a little less than that proposed by Vollenweider (in press) as "permissible"; i.e., an oligotrophic rate (see page 14).

The Minnesota Pollution Control Agency has stipulated phosphorus removal at the villages of Belgrade and New London and the City of Spicer (Schilling, 1974). Although the primary receiving waters (Nest and Woodcock lakes) probably will benefit most, the resulting reduction in loading to Green Lake should improve the tropnic condition there as well.

2. Non-point sources (see page 14)--The nutrient exports of the Nest Lake outlet were quite low because of entrapment in Nest Lake.

In all, non-point sources are estimated to have contributed nearly 49% of the total phosphorus load to Green Lake during the sampling year.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry†:

1. Surface area: 5,406 acres.
2. Mean depth: 21 feet.
3. Maximum depth: 110 feet.
4. Volume: 113,526 acre/feet.
5. Mean hydraulic retention time: 3.7 years.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area††	Mean flow††
Nest Lake outlet	123.0 mi^2	37.5 cfs
Woodcock Lake outlet*	?	?
Minor tribuaries & immediate drainage -	6.6 mi^2	4.9 cfs
Totals	129.6 mi^2	42.4 cfs

2. Outlet -

Middle Fork, Crow River	138.0 mi^2**	42.4 cfs

C. Precipitation***:

1. Year of sampling: 28.1 inches.
2. Mean annual: 24.5 inches.

---

† DNR lake survey map (1970); mean depth by random-dot method.
†† Drainage areas are accurate within ±5%; mean daily flows are accurate within ±10%; and ungaged flows are accurate within ±10 to 25% for drainage areas greater than 10 mi^2.
* Woodcock Lake has a high-water overflow to Green Lake (Lang, 1972), but the volume is not known.
** Includes area of lake.
*** See Working Paper No. 1, "Survey Methods".

III. LAKE WATER QUALITY SUMMARY

Green Lake was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page vi). During each visit, a single depth-integrated (15 feet to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were 44 feet at station 1 and 50 feet at station 2.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/25/72)		
Temperature (Cent.)	7.8	7.9	7.8	8.0
Dissolved oxygen (mg/l)	5.4	9.2	9.5	11.2
Conductivity (μmhos)	324	341	345	360
pH (units)	8.3	8.4	8.4	8.4
Alkalinity (mg/l)	171	175	175	178
Total P (mg/l)	0.014	0.016	0.016	0.020
Dissolved P (mg/l)	0.006	0.009	0.009	0.012
NO_2 + NO (mg/l)	0.090	0.091	0.090	0.100
Ammonia (mg/l)	0.030	0.040	0.040	0.050
		ALL VALUES		
Secchi disc (inches)	90	110	105	138

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
07/02/72	1. Microcystis	1,826
	2. Dinobryon	1,808
	3. Fragilaria	669
	4. Chroococcus	344
	5. Pediastrum	235
	Other genera	398
	Total	5,280
08/21/72	1. Dinobryon	675
	2. Microcystis	476
	3. Anabaena	139
	4. Merismopedia	120
	5. Flagellates	84
	Other genera	260
	Total	1,754
10/25/72	1. Fragilaria	1,491
	2. Flagellates	738
	3. Dinobryon	572
	4. Anabaena	527
	5. Melosira	301
	Other genera	1,491
	Total	5,120

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
07/02/72	01	5.7
	02	6.4
08/31/72	01	5.5
	02	4.1
10/25/72	01	3.5
	02	4.0

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.011	0.118	1.3
0.005 P	0.016	0.118	2.6
0.010 P	0.021	0.118	3.1
0.020 P	0.031	0.118	3.2
0.050 P	0.061	0.118	3.4
0.050 P + 10.0 N	0.061	10.118	24.5
10.0 N	0.011	10.118	1.5

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Green Lake at the time the sample was collected was moderate. Also, the increasing yields with increasing increments of orthophosphorus (to about 0.020 mg/l) show that

Green Lake was phosphorus limited at the time the sample was collected in October, 1972. Note that the addition of only nitrogen produced a yield not significantly different than the control yield.

Lake data indicate phosphorus limitation in the lake in August (N/P ratio = 28/1) but nitrogen limitation in July (N/P ratio = <1/1).

IV. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the Minnesota National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page vi), except for the high runoff month of May when two samples were collected, and January when the Nest Lake outlet was not sampled because of low flows. Sampling was begun in October, 1972, and was completed in September, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Minnesota District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*. Nutrient loadings for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated by using the means of the nutrient loads, in lbs/mi^2/year, in streams tributary to nearby Big Stone Lake at stations 2709D-1, E-1, F-1, and G-1 and multiplying the means by the Green Lake ZZ area in mi^2.

The operator of the Belgrade wastewater treatment plant provided monthly effluent samples and corresponding flow data; however, the Village of New London declined participation in the Survey and nutrient loads were estimated at 2.5 lbs P and 7.5 lbs N/capita/year. Since Nest Lake, tributary to Green Lake, retained 56% of the total phosphorus load and 16% of

* See Working Paper No. 1.

the total nitrogen load, the nutrient loads attributed to these point sources are 44% of the phosphorus and 84% of the nitrogen measured or estimated at the STP's.

The loads attributed to the Nest Lake outlet are measured loads minus the point-source loads.

The effluent of the City of Spicer wastewater treatment plant is discharged to Woodcock Lake, and there is a high-water overflow to Green Lake (Lang, 1972). The overflow was not sampled during the Survey year, and the nutrient loads to Green Lake attributed to the City of Spicer were estimated at 2.5 lbs P and 7.5 lbs N/capita/year; it was assumed that Woodcock Lake had the same degree of nutrient retention as Nest Lake and overflowed in March, April, and May of the sampling year.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Belgrade	713	act. sludge	0.131	Middle Fork, Crow River
New London	736	prim. clarifier	0.129**	Middle Fork, Crow River
Spicer	586	trickling filter	0.192†	Woodcock Lake to Green Lake

* 1970 Census.
** Beaton and McGuire, 1969.
† Lang, op. cit.

2. Known industrial* -

Name	Treatment	Mean Flow (mgd)	Receiving Water
New London Creamery Assoc.	New London STP	?	(Crow River)
Gordhammer's Food Mkt.	Belgrade STP	?	(Crow River)
Farmers Coop. Assoc.	Belgrade STP	?	(Crow River)
Engwall Bros. Locker, Spicer	septic tank & soil absorb.	?	no discharge

* Beaton and McGuire, 1969.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load) -		
Nest Lake outlet	1,230	27.4
b. Minor tributaries & immediate drainage (non-point load) -	130	2.9
c. Known municipal -		
Belgrade (indirect)	890	19.8
New London (indirect)	810	18.0
Spicer (indirect)	160	3.6
d. Septic tanks* -	430	9.6
e. Known industrial (to municipal STP's)		-
f. Direct precipitation**	840	18.7
Total	4,490	100.0

2. Outputs -

Lake outlet - Middle Fork, Crow River	1,460

3. Net annual P accumulation - 3,030 pounds

* Estimated 650 dwellings, 1 camp, & 3 resorts on lakeshore (Beaton & McGuire, 1969); see Working Paper No. 1.
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Nest Lake outlet	107,710	57.3
b. Minor tributaries & immediate drainage (non-point load) -	2,440	1.3
c. Known municipal -		
Belgrade (indirect)	4,120	2.2
New London (indirect)	4,640	2.5
Spicer (indirect)	920	0.5
d. Septic tanks* -	16,140	8.6
e. Known industrial (to municipal STP's)		-
f. Direct precipitation** -	52,080	27.6
Total	188,050	100.0

2. Outputs -

Lake outlet - Middle Fork, Crow River	85,800

3. Net annual N accumulation - 102,250 pounds

* Estimated 650 dwellings, 1 camp, & 3 resorts on lakeshore (Beaton & McGuire, 1969); see Working Paper No. 1.
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Nest Lake outlet	10	876

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving waters would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

	Total Phosphorus		Total Nitrogen	
Units	Total	Accumulated	Total	Accumulated
lbs/acre/yr	0.8	0.6	34.8	18.9
grams/m^2/yr	0.09	0.06	3.9	2.1

Vollenweider loading rates for phosphorus ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Green Lake:

"Dangerous" (eutrophic rate)	0.26
"Permissible" (oligotrophic rate)	0.13

V. LITERATURE REVIEWED

Beaton, Perry T., and John F. McGuire, 1969. Report memorandum on water quality of Green Lake, Kandiyohi County. MPCA, Minneapolis.

Lang, Derald E., 1972. Report on operation of wastewater treatment works at Spicer, June, 1972. MPCA, Minneapolis.

Schilling, Joel, 1974. Personal communication (lake map; P removal at Belgrade, New London, and Spicer). MPCA, Minneapolis.

Vollenweider, Richard A., (in press). Input-output models. Schweiz. A. Hydrol.

VII. APPENDICES

APPENDIX A

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR MINNESOTA 10/30/74

LAKE CODE 27H2 GREEN LAKE

TOTAL DRAINAGE AREA OF LAKE 138.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
27H2A1	138.00	15.40	17.00	26.40	71.90	97.50	89.20	63.60	39.10	29.30	21.10	17.70	18.20	42.38
27H2B1	123.00	13.70	14.40	25.00	64.40	86.70	80.50	56.60	33.90	26.00	18.30	15.10	15.80	37.63
27H2Z7	15.00	2.43	2.45	2.32	7.39	10.90	12.20	7.34	3.40	3.38	2.59	1.86	2.13	4.87

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 138.00
SUM OF SUB-DRAINAGE AREAS = 138.00

TOTAL FLOW IN = 508.76
TOTAL FLOW OUT = 507.30

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
27H2A1	10	72	57.80	15	54.00				
	11	72	76.40	3	72.00				
	12	72	63.20	9	60.00				
	1	73	57.60	6	58.00				
	2	73	47.13	4	50.00				
	3	73	107.30	10	64.00				
	4	73	129.60	14	130.00				
	5	73	108.00	6	105.00	19	99.00		
	6	73	58.50	10	74.00				
	7	73	18.60	14	21.60				
	8	73	30.40	11	27.10				
	9	73	15.40	6	26.00				
27H2B1	10	72	49.10	15	46.00				
	11	72	64.30	3	61.00				
	12	72	45.60	9	51.00				
	1	73	49.50	6	50.00				
	2	73	33.53	4	42.00				
	3	73	98.40	10	54.00				
	4	73	114.00	14	115.00				
	5	73	95.00	6	91.00	19	87.00		
	6	73	52.10	10	66.00				
	7	73	16.40	14	19.00				
	8	73	26.00	11	23.10				
	9	73	13.50	6	22.80				
27H2Z7	10	72	7.02	15	6.60				
	11	72	7.93	3	7.50				
	12	72	6.13	9	6.90				
	1	73	8.66	6	8.80				
	2	73	6.71	4	7.20				
	3	73	9.14	10	5.50				
	4	73	13.10	14	13.00				
	5	73	12.16	6	12.00	19	11.00		
	6	73	7.93	10	10.00				
	7	73	2.11	14	2.47				
	8	73	2.62	11	2.33				
	9	73	1.76	6	2.97				

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/10/30

274201
45 15 45.0 094 55 42.0
GREEN LAKE
27 MINNESOTA

11EPALES 2111202
4 0032 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	15 15	0000	21.1	10.2	105	340	8.30	175	0.070	0.040	0.015	0.011
	15 15	0015	21.0	10.0		340	7.90	181	0.040	0.010	0.014	0.010
	15 15	0030	17.0	5.8		450	8.30	244	0.110	0.150	0.838	0.720
72/08/31	15 30	0000			90	340	8.20	164	0.050	0.080	0.016	0.007
	15 30	0004	20.5	7.4		340	8.20	167	0.050	0.100	0.010	0.005
	15 30	0015	20.4	7.0		380	8.20	170	0.060	0.100	0.012	0.005
	15 30	0025	19.7	6.4		340	8.05	170	0.060	0.130	0.012	0.004
	15 30	0035	19.5	5.8		340	7.95	171	0.060	0.120	0.012	0.005
	15 30	0044	19.1	4.0		480	7.80	175	0.050	0.160	0.014	0.006
72/10/25	17 30	0000			138	345	8.40	173	0.090	0.050	0.014	0.008
	17 30	0004	7.8	5.4		324	8.41	172	0.090	0.030	0.020	0.010
	17 30	0015	7.8	4.4		325	8.40	171	0.090	0.030	0.020	0.012
	17 30	0040	7.8	4.5		324	8.40	172	0.090	0.030	0.015	0.006

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	15 15	0000	5.7J
72/08/31	15 30	0000	5.5J
72/10/25	17 30	0000	3.5J

J VALUE KNOWN TO BE IN ERROR

02

STORET RETRIEVAL DATE 72/10/30

27M202
45 15 55.0 094 53 00.0
GREEN LAKE
27 MINNESOTA

11EPALES
3

2111202
0015 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/07/02	17 15	0000	22.5	12.2	104	330	8.30	175	0.030	0.010	0.014	0.008
	17 15	0025	18.3	7.4		350	8.00	174	0.040	0.010	0.030	0.012
72/08/31	16 00	0000			90	340	8.25	165	0.100	0.130	0.015	0.013
	16 00	0004	20.8	7.4		340	8.25	163	0.100	0.170	0.014	0.010
	16 30	0010	20.7	8.8		338	8.20	164	0.100	0.130	0.013	0.011
72/10/25	16 45	0000			132	350	8.40	178	0.090	0.050	0.016	0.009
	16 45	0004	8.0	9.5		350	8.40	175	0.090	0.040	0.017	0.009
	16 45	0015	7.4	9.4		345	8.40	177	0.090	0.040	0.016	0.009
	16 45	0030	7.4	9.8		345	8.30	178	0.090	0.040	0.015	0.008
	16 45	0050	7.4	11.2		360	8.30	176	0.100	0.050	0.015	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/07/02	17 15	0000	6.4 J
72/08/31	16 00	0000	4.1 J
72/10/25	16 45	0000	4.0 J

J VALUE KNOWN TO BE IN ERROR

APPENDIX C

TRIBUTARY DATA

STORET RETRIEVAL DATE 74/10/30

27K2A1 L527K2A1
45 16 00.0 094 52 00.0
MIDDLE FORK CROW RIVER
27 7.5 HANICK
O/SWEET LAKE
CO HWY 4 400S E EDGE OF LAKE
11PALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00631 NO2&NO3 N-TOTAL MG/L	00625 TOT K JEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	11	45	0.05K	0.560	0.058	0.005K	0.019
72/11/03	14	10	0.113	0.560	0.052	0.011	0.013
72/12/09	10	30	0.140	0.750	0.024	0.005K	0.015
73/01/04	11	30	0.147	0.420	0.089	0.010	0.015
73/01/10	13	15	0.110	0.690	0.029	0.005K	0.015
73/04/14	09	25	0.039	0.710	0.010	0.013	0.015
73/05/05	11	00	0.060		0.078	0.065K	0.020
73/05/19	08	40	0.027	0.660	0.017	0.035K	0.020
73/06/10	10	33	0.010K	0.600	0.028	0.005K	0.015
73/07/14	11	30	0.010K	1.900	0.273	0.014	0.025
73/08/11	11	35	0.010K	0.670	0.032	0.008	0.020
73/09/06	20	25	0.014	2.600	0.610	0.019	0.020

K VALUE KNOWN TO BE LESS THAN INDICATED

STORET RETRIEVAL DATE 74/10/30

27H2R1 LS27H2R1
45 14 30.0 094 56 00.0
NEST LK/GREEN LK CONNECTION
27 7.5 NEW LONDON
1/GREEN LAKE
CO HWY XING 1.5 MI NNE OF SPICER
11FPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/10/15	11 30		0.093	1.680	0.120		0.039
72/11/03	13 55		0.020	0.840	0.054	0.007	0.032
72/12/09	10 20		0.078	0.950	0.072	0.010	0.021
73/01/06	11 45		0.065	1.150	0.110	0.019	0.025
73/02/04	11 15		0.126		0.220	0.017	0.045
73/03/10	13 00		0.230	0.900	0.023	0.013	0.037
73/04/14	09 30		0.025	2.100	0.005K	0.006	0.030
73/05/06	10 30		0.046	1.900	0.026	0.007	0.035
73/05/19	08 25		0.015	0.760	0.019	0.014	0.045
73/06/10	10 30		0.020	1.000	0.012	0.007	0.035
73/07/14	11 00			3.500	0.180	0.020	0.070
73/08/11	11 15		0.010K	1.200	0.033	0.017	0.045
73/09/06	20 50		0.027	4.000	0.370	0.017	0.055

K VALUE KNOWN TO BE LESS THAN INDICATED